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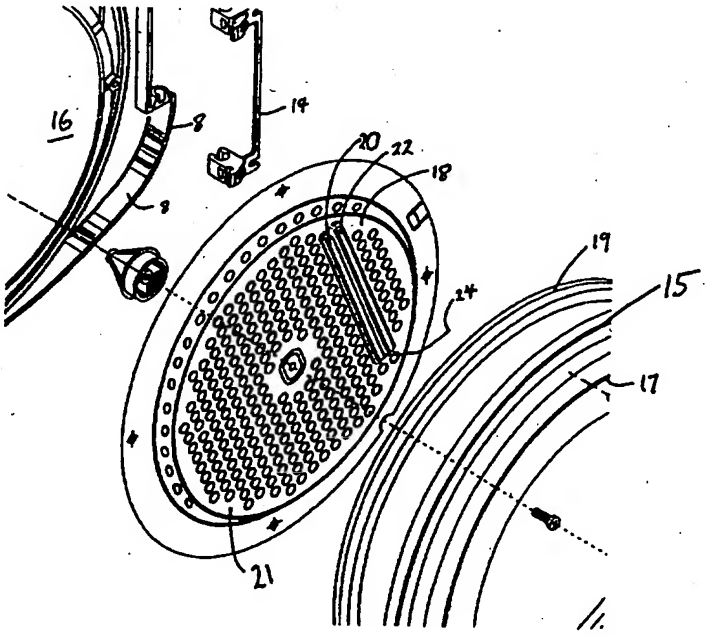

(57) Abstract

The present invention relates to clothes dryers and other drying apparatus, such as tumble dryers. The invention concerns the use of a sensing means which senses or measures an electrical characteristic, such as voltage, impedance or current to determine moisture content and load size, and so as to monitor the load periodically. The sensing means is located in an exhaust outlet path and simultaneously on a door of the dryer. Another feature of the invention is the provision of a no monitoring period at the start of a cycle, so as to allow clothes to be properly distributed in the dryer. By doing this, more accurate measurements are obtained.

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A DRYING APPARATUS

FIELD OF THE INVENTION

The present invention relates to a drying apparatus; a method of controlling a drying apparatus; clothes dryers; and a sensing means and control means for use with a drying apparatus, such apparatus including tumble dryers for clothes and the like.

BACKGROUND OF THE INVENTION

Prior art automatic tumble type clothes dryers have been automatically controlled by several methods. Some of these methods include control systems which require the periodic sensing of temperature or humidity of the air being exhausted from a drying apparatus. The difficulty with such systems is that the ambient temperature and humidity causes inaccurate readings of the clothes being dried such that the automatic systems will shut down the drying process before the drying process has been completed. Thus when a user takes clothes out of such a prior art dryer with these features, the clothes may still be considered to be in a wet condition.

The Australian Standards for clothes dryers permit a dryer to be called an "automatic clothes dryer" if when it is operated automatically, it achieves a moisture content of the clothes of no greater than 6% of the weight of a garment by the time the drying process is completed.

Prior art clothes dryers have been relatively inaccurate in achieving this goal. To be more precise they tend to over achieve the goal and reduce the water or moisture content to well below the 6% figure. By over-dying the clothes, the machines generally utilise more electrical power and energy. This makes the products unattractive in the marketplace particularly in the environmental climate currently existing whereby the energy rating of a product is a significant influence on the buying public.

SUMMARY OF THE INVENTION

The invention provides a drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus and a control system to control said blower, motor and element, said apparatus

further including a sensing means or a part thereof located on a door and or in an exhaust path through said door of said drying apparatus, said sensing means being able to interact with said load to be dried to obtain a signal which includes information relating to the frequency of contacts with said sensing means or a part thereof to thereby determine the approximate size of the load contained in said drying apparatus and information relating to the moisture content of said load, said control system also receiving and interrogating said signal, said apparatus being further characterised by the control system processing said information from said sensing means when an initial distribution period has elapsed whereby said load is distributed in said drying apparatus by said drum rotating.

The invention also provides a drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus and control system to control said blower, motor and element, said apparatus including a sensing means to determine the moisture content of a load placed in said drying apparatus, said sensing means able to sense an electrical characteristic sensitive to moisture content, said sensing means cooperating with a control system to control at least heat source and a fan means, said drying apparatus being characterised by said sensing means or a part thereof being mounted in a door and or an exhaust outlet of said drying apparatus .

The invention further provides a drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus and control system to control said blower, motor and element, said apparatus including a sensing means or a part thereof to interact with said load to be dried to obtain a signal which includes information relating to the frequency of contacts with said sensing means or part thereof to thereby determine the approximate size of the load contained in said drying apparatus and information relating to the moisture content of said load.

The invention still further provides a drying apparatus including a blower to blow air through a load when placed in said drying apparatus , a motor to rotate a drum to receive said load when

placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus and control system to control said blower, motor and element, said apparatus including a sensing means or a part thereof to interact with said load when placed in said drying apparatus to obtain a signal which includes information relating to the moisture content of said load when in said drying apparatus, said apparatus being characterised by the control system initiating the processing of said signal from said sensing means after an initial distribution period has elapsed after the drying apparatus has activated said motor to rotate said drum.

Preferably said sensing means utilises at least one electrical characteristic to obtain said signal being one of, or a combination of the following: resistivity, conductivity, impedance, inductance, voltage or current.

Preferably said sensing means or a part thereof is mounted on a door and or in an exhaust path of said drying apparatus.

Preferably said sensing means produces said signal consisting of pulses which are summed so as to determine a frequency of contacts with said sensing means or part thereof to thereby determine the approximate size of the load contained in said drying apparatus.

Preferably said drying apparatus includes at least one comparator circuit cooperating with said control system and or said sensing means.

Preferably said sensing means utilises alternating current to produce a signal made up of a pulse or number of pulses when said articles make contact with said sensing means or part thereof.

Preferably a first of said at least one comparator circuit senses pulses at a low threshold level of said electrical characteristic.

Preferably a second of said at least one comparator circuit senses pulses at a higher threshold level of said electrical characteristic relative to said low threshold level of said electrical characteristic.

Preferably said comparator circuit monitors, processes or interprets pulses at said low threshold level during an initial drying period, after an initial distribution period.

Preferably said control system processes pulses and or threshold levels of an electrical characteristic received from said sensing means to determine an amount of adjustment time to add to an initial drying period, or to determine that no further drying is required and to rotate the load in said drum and heat it via said element heating said air for a predetermined period of time.

Preferably said drying apparatus includes a means adapted to sum pulses produced by said load contacting said sensing means or a part thereof, over a predetermined period of time.

Preferably said control system adds drying time at the end of an initial drying period if required, said initial drying period being concurrent with or after an initial distribution period.

Preferably said drying apparatus is a clothes dryer or a tumble clothes dryer .

Preferably said sensing means or a part thereof includes two terminals of an impedance detection circuit.

Preferably said terminals are each an elongate metal bar which are the part of said sensing means positioned on a door and in an outlet path of said drying apparatus.

Preferably said elongate metal bars are electrically separated from each other.

Preferably said metal bars are positioned parallel to each other.

The invention also provides a method of controlling a drying apparatus using a sensor means and control system, in combination, said drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus and control system to control said blower, drum and element, said method including the steps of:

1. said sensor means gathering information about the moisture content of said load to be dried when said load is placed in said drying apparatus;

2. if sufficient moisture content is detected, said sensing means being able to communicate with said control system to determine an adjustment period required to be added to an

initial drying period in order to bring said load to a moisture content below a predetermined limit;

3. said control system being able to operate said drying apparatus for said initial drying period until such time as said load is approximately at said predetermined limit;

4. during step 3, using said sensor means and control system to monitor electrical characteristics, representative of the moisture content of said load during the drying process;

5. sensing said moisture content until it has reached said predetermined limit;

6. said control system running said drying apparatus for said adjustment period after said initial period is completed.

Preferably an additional step is added whereby if insufficient moisture content is detected, said control system operates said drying apparatus for a predetermined period.

Preferably an additional step 7 is added whereby said control system produces a cool down period wherein said blower is functioning but said element is not heating air, after said predetermined period, or said adjustment period or said initial drying period.

Preferably before step 1, an additional step is added whereby said control system will activate said motor to rotate said drum to cause said load to be distributed in the drying apparatus for a predetermined distribution period during which predetermined distribution period no information from said sensor means is processed by said control means.

Preferably said element heats said air and said blower is operated during said predetermined distribution period.

Preferably said predetermined distribution period is approximately 2 minutes, or is in the range of 5 to 10 minutes is said sensor means uses humidity readings to obtain an indication of moisture content..

Preferably step 1 is conducted for a period of 1 minute.

Preferably the adjustment period is a discrete time period.

Preferably said adjustment period can be either 0, 10, 15 or 25 minutes depending upon the moisture content.

Preferably said adjustment period can be either 0, 20, 30 or 50 minutes depending upon the moisture content.

Preferably during step 4, said monitoring is performed by means of a low threshold level of voltage or current, or a high level of impedance or resistance.

Preferably during step 4, the monitoring can be one of the following: continual, intermittent, or intermittent for discrete periods of on and off times.

Preferably said drying apparatus is clothes dryer or a tumble clothes dryer.

The invention further provides an automatic clothes dryer including a blower to blow air through a load when placed in said dryer, a motor to rotate a drum to receive said load when placed in said dryer, an air heating element to heat air to dry said load when placed in said dryer and a control system to control said blower, motor and element, said dryer further including a sensing system to communicate with said control system so that said control system can also obtain information about an electrical characteristic from said sensing system indicative of the moisture content of a load to be dried and or the size of such a load, said dryer being further characterised by the control system or processing said information from said sensing system only after an initial distribution period has elapsed.

Preferably said initial distribution period is between 15 seconds and 180 seconds.

The invention further provides a sensing apparatus in combination with a control system, for use with a drying apparatus, said sensing apparatus including a sensing means to sense an electrical characteristic sensitive of the moisture content of a load to be dried by said drying apparatus, said sensing means upon sensing said electrical characteristic, communicating with said control system which is adapted to adjust the length of drying time of said load dependent upon said moisture content.

Preferably said control system adds drying time at the end of an initial drying period.

Preferably the sensing means or a part thereof can sense a magnitude of an electrical characteristic in response to the level of moisture present in said load as a result of the interaction between said object or article and said sensing means.

Preferably the sensing means can sense a range of impedances, voltages, current, resistance, conductivity or inductance.

Preferably the number of contacts made by said load with said sensing means can be summed, to there by determine a frequency for said contacts.

Preferably said control system can record a frequency of said contacts of at least one range of magnitudes of a sensed electrical characteristic.

Preferably said sensing means or a part thereof is located in an exhaust path of a drying chamber of said drying apparatus.

Preferably said sensing means or a part thereof is located in an exhaust path mounted in a door of said drying apparatus.

Preferably when contact has been made by said load with said sensing means or a part thereof thereby allowing the sensing of an electrical characteristic, the sensor means communicates with said control system so that the control system increments said drying time in proportion to the magnitude and frequency of said electrical characteristics which is representative of said moisture content, and load size respectively.

Preferably said drying apparatus is a tumble clothes dryer or a clothes dyer.

Preferably said load is clothes and/or articles or objects made of cloth and/or similar materials.

Preferably such sensing means or a part thereof includes two terminals of an impedance detection circuit.

Preferably said terminals are each an elongate bar, which is a part of said sensing means positioned on a door and in an outlet path of said drying apparatus.

Preferably said elongate metal bars are electrically separated from each other.

Preferably said metal bars are positioned parallel to each other.

The features of the inventions described above can lead to better consistency of results in the achievement of the moisture contents which satisfy established standards without the over consumption of energy and without over-dying of articles. Appliances embodying such inventive features can result in a simpler appliance operation by comparison with other automatic dryer appliances. Finally the feature of positioning into an exhaust a sensing means which utilises an electrical characteristic representative of moisture content, the flowing of air will tend to direct clothes and cloth articles towards the sensor and thus give a more accurate reading of the moisture content during the drying process.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described, by way of example only with reference to the accompanying drawings in which:

Figure 1 is an exploded perspective view of a front loading, door venting tumble, clothes dryer which embodies the present invention;

Figure 2 is a larger scale exploded perspective view of a perforated screen which includes a sensor mechanism from the apparatus of figure 1;

Figures 3 and 4 are circuit diagrams of a control circuit and sensing system for use with the apparatus of figure 1 and 2, figs 3 and 4 representing one circuit diagram inclusive of both systems; and

Figure 5 to 12 are the flow charts which model the manner in which the control circuit functions.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Illustrated in figure 1 is a tumble clothes dryer 2 of the front loading type which includes a cylindrical open ended rotatable drum 4, which rotates on a substantially horizontal axis, for tumbling and rotating clothes placed therein. The clothes dryer 2 includes a heating element, a blower and a motor (each of which is not illustrated) to rotate drum 4, as is the case with conventional clothes dryers. Clothes or cloth articles can be placed in the clothes dryer 2 via a circular front opening 6. The front opening 6 is closed by means of a door 8 which is hingedly

connected to the front surface 10 of the dryer 2, by means of hinge pin mechanism 12 and a receiving portion 14. The door 8 includes a circular seal 17 attached to it. The seal 17 is mounted on a frame 15 to seal against surface 10 around the front opening 6, as is the case with conventional clothes dryers.

An aperture 16 in door 8 is partially occluded by means of a circular perforated plate 18 to such an extent that when the blower (not illustrated) is operating, a positive pressure is present inside the drum 4. A seal 19 engages both the periphery of perforated plate 18 and frame 15, so that when said door 8 is assembled and positioned against surface 10 to close front opening 16 air can only escape from the dryer 2 through the perforated plate 18.

The perforated plate 18 has mounted on its inwardly directed surface 21, two elongate metal bars 20 and 22. As is more clearly seen in figure 2 the metal bars 20 and 22 are located in an elongate rectangular holder 24 and are separated, so as to be electrically isolated, by a distance of approximately 5 millimetres. The holder 24 is of a plastic construction and is preferably injection moulded. When the door 8 is closed, the bars 20 and 22 are in the volume contained by dryer 2. The rest of the parts illustrated in figure 1 are the same as those generally provided in conventional tumble clothes dryers and no further description will be made of them, as they have no direct relationship to the inventions included in this specification.

The metal bars 20 and 22 are a part of a sensing or detection system which includes an impedance detection circuit 28 as illustrated in figure 4. The metal bars 20 and 22 are connected in series with two resistors 30 and 32 to form a voltage divider 34. An alternating current signal is applied across the voltage divider 34, and the voltage level detected across the two metal bars 20 and 22 (when clothing or articles of cloth make contact with each metal bar 20 and 22 simultaneously) will be proportional to the impedance (provided by the clothing) across the two metal bars 20 and 22. The magnitude of impedance or voltage will be proportional to the moisture content of the clothing article making contact with bars 20 and 22.

A peak detector circuit 35 made up of a first part 36 (see Fig 4) and a second part 38 (see Fig 3). As wet clothes contact simultaneously the two metal bars 20 and 22, signal outputs being a series of pulses from impedance detection circuit 28 will proceed to the peak detector 35. The

peak detector 35 is used to determine the peak or the level of magnitude of the signal received, which will be proportional to the moisture level of the clothes.

The peak detector circuit 35 includes two comparators 39 and 43 (see Fig 3) to interrogate or process the signal and pulses mentioned above. One comparator has a threshold voltage of 5Vdc to high level signals, (or impedances of approximately 7MΩ). The other comparator 39 has a threshold of 0.4 to 1.2 Vdc, (or impedances of approximately 25MΩ) which is adjustable with a trim pot 41. The comparator 39 is for detecting low level signals which may represent partially dried clothes at the start of a cycle as the clothes dry or other low moisture content situations..

The control circuit 40 depending upon the cycle and timing (as is explained below), will determine whether the high or low level comparator (43 or 39 respectively) is utilised. If the sensing system senses voltage, current, conductivity or inductance, high magnitude of these will represent high threshold levels, whereas low magnitudes of resistance or impedance will reflect high threshold levels. The reverse is true for low threshold levels.

The voltage level of pulses will be proportional to the moisture level in the clothes, and the frequency of pulses will be proportional to the amount of clothes in the dryer.

The control circuit 40 (of figures 3 and 4) is a purpose built device which provides control of the dryers blower, rotating drum, air heating element, selection of normal or auto operation, extra drying, and other control features. The control circuit in figure 3 and 4 is one circuit with those portions of figure 3 electrically connected to those portions of figure 4, by means of a connection strip J9, which is included in both figures, at the bottom right of fig 3 and top left of fig 4.

The control circuit 40 performs these functions by a micro-processor integrated circuit 48 and a Darlington Pair Driver integrated circuit 50. The control circuit 40 via the microprocessor 50 also utilises information derived from the impedance detection circuit 28 and peak detector circuit 35 to provide an automatic control system for the dryer 2. The control circuit includes integrated circuits 48 and 50 which are programmed in accordance with the following description, as well as to perform the control instructions for the normal running of the dryer.

The perforated plate 18 is sealed by means of seal 19 to the frame 15. In this way, air exhausted from dryer 2, must pass out the perforated plate 18.

When clothes are loaded into the drum 4 of the dryer 2, the dryer is set to auto by switch 44 (see Fig 3) the first two minutes of the initialised drying cycle are used to properly distribute the clothes in the drum. Preferably the heater element and blower are also on but if desired, one or both of the heater element and blower can remain off. One reason why both may be switched on is that the user will be assured that the dryer is properly operating, at the time of activating or initiating the drying process. During this two minutes the sensing by the impedance detection circuit 28 and information from peak detector circuit 35 are not processed by the control circuit 40. This results in an improved consistency and accuracy of the decisions made by the control circuit 40 because clothes are firstly or initially evenly distributed throughout the drum 4. So as to ensure a generally regular frequency of pulses or signals from the sensing period.

After the initial two minutes drying and distribution time, the control circuit 40 monitors the pulses generated at a low threshold level for a one minute period as they emanate from the impedance detection unit 28. If no pulse is detected, for example because a single item of clothing may be located in the dryer, or the articles to be dried are included on a drying rack outside of the door, then the control circuit 40 will make the dryer operate for a thirty minute drying period which will include a twelve minute cool down period.

If more than one pulse is detected, the control circuit 40 advances to the next step of the cycle.

In this next step of the cycle the control circuit 40 detects pulses generated at the impedance detection circuit 28 at the higher threshold limit for one minute. It will also measure the total time during which the pulse level is above a predetermined threshold such as the generation of 5 volts DC or for example an impedance of approximately 7MΩ. This sum of the pulses and the amount of time and the threshold level will determine the amount of extended drying time selected by the control circuit. Where normal dryness is selected the initial drying time will preferably be extended for approximately 25 minutes, if the total time measured is longer than 20 seconds with greater than approximately 1024 pulses. If the total time measured in which

pulses occurred is less than 2.5 seconds which equates to approximately less than 256 pulses the initial drying time is extended by a further 10 minutes. If the total time for which pulses were measured is between 2.5 and 20 seconds then the control circuit 40 applies an extended drying time of approximately 15 minutes. If the appliance also includes an extra dryness selection, then these times are doubled making the extended drying times available as 10 minutes, 15 minutes, 20 minutes, 25 minutes, 30 minutes, and 50 minutes.

After determining the extended drying time the control circuit 4 then monitors the input pulses at the low threshold continuously or may also do so intermittently for discrete periods of on and off times. If the control circuit 40 does not detect any pulse in a period of 3 minutes it then advances to the next stage of the cycle. If any pulse is still being detected at the end of 168 minutes the control circuit 40 will exit the cycle and will then operate a cool down cycle in order to cool the clothes down.

If the control circuit 40 continues drying for the extended drying time it then also proceeds to cool down.

If desired the drum 4 can be rotated in a single direction at all times or it may be rotated in a forward and reverse direction. If a forward and reverse direction is utilised, the dryer is preferably made to rotate in a forward direction for approximately 58 seconds, stop for two seconds and then reverse direction for another 58 seconds and stop for 2 seconds and so on.

The above describes the automatic drying features of an appliance embodying the invention. However, if desired the automatic control can be disabled by closing switch 46 in circuit 40 and the machine made to function in a manual fashion whereby the operator chooses the amount of time and temperature at which the clothes or articles are dried.

The initial two minute drying and distribution period is of this length of time, because of the type of sensing means utilised. If the moisture sensing means was a humidity based sensor, then an initial period of 5 to 10 minutes would be required for the drying and distribution period.

The above provides an improved controlling circuit particularly when light loads are concerned. The above controlling mechanism allows the clothes to be dried to a trip level of approximately 6% moisture content or thereabouts. The extended drying period further extends

the drying to bring the moisture content down further to take into account different weights of threads, different types of fabric which can hold moisture and absorb it and will not release it under the same circumstances as cloth which more readily releases its water and moisture.

This feature allows the appliance to achieve the same amount of drying to acceptable levels with less energy by comparison to prior art machines. The resulting control mechanism has simpler operation and is relatively more effective in the results obtained.

The positioning of the metal bars 20 and 22 on the perforated plate 18 ensures that as the blower unit blows air from inside the drum 4 through the perforated plate 18 the clothes are forced by the movement of air, up against the metal bars 20 and 22. For most clothes contained in the dryer 2 this will ensure improved readings and more consistent readings than have been possible by the previous sensing methods. The frequency of pulses resulting from the impedance detection circuit 28 is such that the greater the frequency will generally indicate that a greater amount of clothes are positioned in the drum 4. Obviously the lower the frequency then less clothes are present. If an article or articles are present but no articles are sensed in the dryer, the 30 minute cycle is instigated by the control circuit 40 should be sufficient in order to dry the not sensed article. Generally, if an article or articles are present but not sensed the reasons may be they are two small.

Prior art systems have attempted to control the length of the cycle by adding time at the beginning of the cycle. However, this does not guarantee drying to the levels required because it does not take into account ambient temperature, pressure and humidity. The sensing and control apparatus described above is independent of the ambient atmospheric conditions. This is because it can be programmed to continually detect, or monitor providing 168 minutes is never exceeded, the moisture content of the clothes or the articles in the dryer before proceeding to the next stage. Other more complicated systems require the operator to decide the size of the load, the level of dryness required and other factors which can make the system difficult to operate.

Whilst the impedance detection circuit 28 utilises an AC signal from which is derived a frequency measure, the impedance detection circuit can be designed to utilise a DC signal

instead. If DC was used, the circuit would instead focus on the length of contact periods relative to the length of non contact periods to determine the size of the load, and the voltage impedance or magnitude of the characteristic measured would indicate the moisture level as with the AC system described above.

The sensing or detecting system described above utilises voltage or impedance. However, modifications could be made so that the sensing or detecting system senses, measures or detects inductance, current, conductivity etc.

In figures 3 and 4 the following components are used unless otherwise specified in the figure of the circuit: all resistors are 1/8W, 5%, 1206, SMD (surface mounted device); all diodes are BAS16, SMD; all capacitors are 50V, ceramic, 1206, SMD. In regards to fig 4 the 1/2W resistors are required for AS3100 (Australian standard) compliance.

Illustrated in figs 5 to 12 is a flow chart of the logic and settings used in the control circuit 40 embodied in the integrated circuit 48 which is the microprocessor. The flow chart is, for convenience, devoid of text in the elements of the figures, and that text is reproduced below. The elements of the flow charts are numbered and the following operations or interrogations occur, when the dryer 2 operates in automatic mode:

100 - Start.

102 - Initialise memory and flags.

104 - Set motor status = forward, heater on, state = initial 2 minutes.

106 - load motor timer = 59 seconds.

108 - load state timer = 2 minutes.

110 - load maximum time timer = 168 minutes.

112 - wait for zero crossing.

114 - wait for main zero crossing.

116 - decrement maximum time timer count = 0? if yes go to subroutine 1, if no, proceed to 118.

118 - decrement motor timer count = 0?, if yes go to subroutine 2 of fig 7, if no, go to 120.

120 - decrement state timer counter = 0? if yes go to subroutine 3 of fig 8, if no, go to 122.

122 - state = monitor pulse for 1 minute? if yes go to subroutine 4 of fig 9, if no, go to 124.

124 - state = monitor pulse 3 minutes? if yes proceed to subroutine 5, if no, return to 114.

Subroutine 2 - fig 7:

126 - motor status = forward? if yes proceed to 128, if no, proceed to 130.

128 - set motor status = forward, stop set motor timer = 1 second then proceed to end of subroutine 2 at 112.

130 - motor status = forward, stop? if yes, go to 132, if no, proceed to 134.

132 - set motor status = reverse set motor timer = 59 sec then proceed to end of subroutine 2 at 112.

134 - motor status = reverse? if yes go to 136, if no, go to 138.

136 - set motor status = rev, stop, set motor timer = 1 sec, then proceed to end of subroutine 2 at 112.

138 - set motor status = forward, set motor timer = 59 seconds proceed to end of subroutine 2 at 112.

Subroutine 3 - Fig 8 (also includes subroutine 1):

140 - state = initial 2 minutes? if yes go to 142, if no, go to 144.

142 - set state = monitor pulse 1 minute, state timer = 1 minute, clear pulse counter. Proceed to end of subroutine 3 at 112.

144 - state = monitor pulse 1 minute? if yes go to subroutine 6 - fig 11, if no, go to 146.

146 - state = monitor pulse 3 minutes? if yes go to subroutine 7 - fig 12, if no, go to 148.

148 - state = extended time? if yes go to subroutine 1 at 152, if no go to 150.

150 - turn motor and heater off then go to 157.

Subroutine 1

152 - set state = cool down, turn heater off, go to 154

154 - set state timer = 12 minutes, reload maximum time timer = 163 minutes, go to end subroutine 3 at 112.

157 - infinite loop.

Subroutine 4 - fig 9.

156 - valid pulse? if no go to end subroutine 4 at 112, if yes go to 158.

158 - increment pulse counter go to end subroutine 4 at 112.

Subroutine 5 - fig 10:

160 - valid pulse? if yes go to 162, if no go to 164.

162 - pulse duration counter < 2? if yes go to 166, if no, go to 168.

164 - pulse duration counter < 2? if yes go to 170, if no, go to 168.

166 - increment pulse duration counter then proceed to end of subroutine 5 at 112.

168 - clear pulse duration counter, set pulse counter = 1 proceed to 172.

170 - clear pulse duration counter proceed to end of subroutine 5 at 112.

172 - set state timer = 1 proceed to end of subroutine 5 at 112.

Subroutine 6 - fig 11:

174 - set state = monitor pulse 3 minutes; state timer = 3 minutes, proceed to 176.

176 - pulse counter > or = 2048? if yes go to 178, if no, go to 180.

178 - program extension time = 25 minutes, proceed to 186.

180 - pulse counter 7 or = 256? if yes go to 182, if no, go to 184.

182 - program extended time = 15 minutes, proceed to 186.

184 - program extended time = 10 minutes, proceed to 186.

186 - clear pulse counter proceed to end of subroutine 6 at 112.

Subroutine 7 fig 17:

190 - pulse counter = 1? if yes go to 192, if no, go to 194.

192 - clear pulse counter, set state timer = 3 minutes.

194 - set state = extended time go to 196.

196 - programmed extended time = 10 minutes? if yes go to 198, if no, go to 200.

198 - set state time = 10 mins proceed to 112.

200 - programmed extended time = 15 minutes? if yes go to 202, if no, go to 204.

202 - set state timer = 15 minutes proceed to end of subroutine at 112.

204 - set state timer = 25 minutes proceed to end of subroutine 7 at 112.

While the above embodiment has been described with to respect a tumble dryer 2, the invention is able to be performed in any drying apparatus in which the sensing mechanism is adapted to make contact with clothes or a load in a dryer. Such a dryer may have a drum which rotates on a vertical axis, or the dryer may be in a cabinet and the sensor mechanism makes contact, with the clothes or load being dried, by moving through the cabinet.

The foregoing describes embodiments of the invention, and modifications by a person skilled in the art can be made thereto without departing from the scope of the present invention.

CLAIMS

1. A drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus, and a control system to control said blower, motor and element, said apparatus further including a sensing means or a part thereof located on a door and or in an exhaust path through said door of said drying apparatus, said sensing means being able to interact with said load to be dried to obtain a signal which includes information relating to the frequency of contacts with said sensing means or a part thereof to thereby determine the approximate size of the load contained in said drying apparatus and information relating to the moisture content of said load, said control system also receiving and interrogating said signal, said apparatus being further characterised by the control system processing said information from said sensing means when an initial distribution period has elapsed whereby said load is distributed in said drying apparatus by said drum rotating.

2. A drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus, and a control system to control said blower, motor and element, said apparatus including a sensing means to determine the moisture content of a load placed in said drying apparatus, said sensing means able to sense an electrical characteristic sensitive to moisture content, said sensing means cooperating with a control system to control at least heat source and a fan means, said drying apparatus being characterised by said sensing means or a part thereof being mounted in a door of said drying apparatus and or an exhaust outlet.

3. A drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus, and a control system to control said blower, motor and element, said apparatus including a sensing means or a part thereof to interact with said load to be dried to obtain a

signal which includes information relating to the frequency of contacts with said sensing means or part thereof to thereby determine the approximate size of the load contained in said drying apparatus and information relating to the moisture content of said load.

4. A drying apparatus including a blower to blow air through a load when placed in said drying apparatus , a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus, and a control system to control said blower, motor and element, said apparatus including a sensing means or a part thereof to interact with said load when placed in said drying apparatus to obtain a signal which includes information relating to the moisture content of said load when in said drying apparatus, said apparatus being characterised by the control system initiating the processing of said signal from said sensing means after an initial distribution period has elapsed after the drying apparatus has activated said motor to rotate said drum.

5. A drying apparatus as claimed in any one of the preceding claims, wherein said sensing means utilises at least one electrical characteristic to obtain said signal being one of, or a combination of the following: resistivity, conductivity, impedance, inductance, voltage or current.

6. A drying apparatus as claimed in any one of claims 3 to 5, wherein said sensing means or a part thereof is mounted on a door and or in an exhaust path of said drying apparatus.

7. A drying apparatus as claimed in any one of claims 1 to 6 wherein said sensing means produces said signal consisting of pulses which are summed so as to determine a frequency of contacts with said sensing means or part thereof to thereby determine the approximate size of the load contained in said drying apparatus.

8. A drying apparatus as claimed in any one of claims 1 to 7, wherein said drying apparatus includes at least one comparator circuit cooperating with said control system and or said sensing means.

9. A drying apparatus as claimed in claim 8, wherein said sensing means utilises alternating current to produce a signal made up of a pulse or number of pulses when said articles make contact with said sensing means or part thereof.

10. A drying apparatus as claimed in claims 8 or 9, wherein moisture content of said load is sensed by a first of said at least one comparator circuit which senses pulses at a low threshold level of said electrical characteristic.

11. A drying apparatus as claimed in any one of claims 8 to 10, wherein moisture content of said load is sensed by a second of said at least one comparator circuit which senses pulses at a higher threshold level of said electrical characteristic relative to said low threshold level of said electrical characteristic.

12. A drying apparatus as claimed in any one of claims 8 to 11, wherein said comparator circuit monitors, processes or interprets pulses at said low threshold level during an initial drying period, after an initial distribution period, so as to sense moisture content during said initial drying period.

13. A drying apparatus as claimed in any one of claims 1 to 12, wherein said control system processes pulses and or threshold levels of an electrical characteristic received from said sensing means to determine an amount of adjustment time to add to an initial drying period, or to determine that no additional drying is required and then drying for an initial drying period only.

14. A drying apparatus as claimed in any one of claims 1 to 13, wherein said drying apparatus includes a means adapted to sum pulses produced by said load contacting said sensing means or a part thereof, over a predetermined period of time.

15. A drying apparatus as claimed in any one of claims 1 and 4 to 14, wherein said control system adds drying time at the end of an initial drying period if required based on information about said load sensed by said sensing system after an initial distribution period, said initial drying period being concurrent with or after said initial distribution period.

16. A drying apparatus as claimed in any one of claims 1 to 15 wherein said drying apparatus is a tumble clothes dryer or a clothes dryer.

17. A drying apparatus claimed in any one of claims 1 to 16 wherein said sensing means or a part thereof includes two terminals of an impedance detection circuit.

18. A drying apparatus as claimed in claim 17, wherein said terminals are each an elongate metal bar which are the part of said sensing means positioned on a door and in an outlet path of said drying apparatus.

19. A drying apparatus as claimed in claim 18 wherein said elongate metal bars are electrically separated from each other.

20. A drying apparatus as claimed, in claims 18 or 19 wherein said metal bars are positioned parallel to each other.

21. A method of controlling a drying apparatus using a sensor means and control system, in combination, said drying apparatus including a blower to blow air through a load when placed in said drying apparatus, a motor to rotate a drum to receive said load when placed in said drying apparatus, an air heating element to heat air to dry said load when placed in said drying apparatus and control system to control said blower, drum and element, said method including the steps of:

1. said sensor means gathering information about the moisture content of said load to be dried when said load is placed in said drying apparatus;

2. if sufficient moisture content is detected, said sensing means being able to communicate with said control system to determine an adjustment period required to be added to an initial drying period in order to bring said load to a moisture content below a predetermined limit;

3. said control system being able to operate said drying apparatus for said initial drying period until such time as said load is approximately at said predetermined limit;

4. during step 3, using said sensor means and control system to monitor electrical characteristics, representative of the moisture content of said load during the drying process;

5. sensing said moisture content until it has reached said predetermined limit;

6. said control system running said drying apparatus for said adjustment period after said initial period is completed.

22. A method as claimed in claim 21 wherein between steps 1 and 2, an additional step is added whereby if insufficient moisture content is detected, said control system operates said drying apparatus for a predetermined period.

23. A method as claimed in claim 21 or 22, wherein an additional step 7 is added whereby said control system produces a cool down period wherein said blower is functioning but said element is not heating air, after said predetermined period, or said adjustment period or said initial drying period.

24. A method as claimed in any one of claims 21 to 23, wherein before step 1, an additional step is added whereby said control system will activate said motor to rotate said drum to cause said load to be distributed in the drying apparatus for a predetermined distribution period during which predetermined distribution period no information from said sensor means is processed by said control means.

25. A method as claimed in claim 24, wherein said element heats said air and said blower is operated during said predetermined distribution period.

26. A method as claimed in any one of claims 21 to 25, wherein said predetermined distribution period is approximately 2 minutes, or is in the range of 5 to 10 minutes is said sensor means uses humidity readings to obtain an indication of moisture content.

27. A method as claimed in any one of claims 21 to 26, wherein step 1 is conducted for a period of 1 minute.

28. A method as claimed in any one of claims 21 to 27, wherein the adjustment period is a discrete time period.

29. A method as claimed in any one of claims 21 to 28, wherein said adjustment period can be either 0, 10, 15 or 25 minutes depending upon the moisture content.

30. A method as claimed in any one of claims 21 to 29, wherein said adjustment period can be either 0, 20, 30 or 50 minutes depending upon the moisture content.

31. A method as claimed in any one of claims 21 to 30, wherein during step 4, said monitoring is performed by means of a low threshold level of voltage or current, or a high level of impedance or resistance.

32. A method as claimed in any one of claims 21 to 31, wherein during step 4, the monitoring can be one of the following: continual, intermittent, or intermittent for discrete periods of on and off times.

33. A method as claimed in any one of claims 21 to 32, wherein said drying apparatus is a clothes dryer or a tumble clothes dryer.

34. An automatic clothes dryer including a blower to blow air through a load when placed in said dryer, a motor to rotate a drum to receive said load when placed in said dryer, an air heating element to heat air to dry said load when placed in said dryer and a control system to control said blower, motor and element, said dryer further including a sensing system to communicate with said control system so that said control system can also obtain information about an electrical characteristic from said sensing system indicative of the moisture content of a load to be dried and or the size of such a load, said dryer being further characterised by the control system processing said information from said sensing system only after an initial distribution period has elapsed.

35. An automatic clothes dryer, as claimed in claim 34 wherein said initial distribution period is between 15 seconds and 180 seconds.

36. A sensing apparatus in combination with a control system, for use with a drying apparatus, said sensing apparatus including a sensing means to sense an electrical characteristic sensitive of the moisture content of a load to be dried by said drying apparatus, said sensing means upon sensing said electrical characteristic, communicating with said control system which is adapted to adjust the length of drying time of said load dependent upon said moisture content.

37. A sensing apparatus and control system in combination as claimed in claim 36, wherein said control system adds drying time at the end of an initial drying period.

38. A sensing apparatus and control system in combination, as claimed in claims 36 or 37, wherein the sensing means or a part thereof can sense a magnitude of an electrical characteristic in response to the level of moisture present in said load as a result of the interaction between said object or article and said sensing means.

39. A sensing apparatus and control system in combination as claimed any one of claims 36 to 38, wherein the sensing means can sense a range of impedances, voltages, current, resistance, conductivity or inductance.

40. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 39, wherein the number of contacts made by said load with said sensing means can be summed, to there by determine a frequency for said contacts.

41. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 40, wherein said control system can record a frequency of said contacts of at least one range of magnitudes of a sensed electrical characteristic.

42. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 41, wherein said sensing means or a part thereof is located in an exhaust path of a drying chamber of said drying apparatus.

43. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 42, wherein said sensing means or a part thereof is located in an exhaust path mounted in a door of said drying apparatus.

44. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 43, wherein when contact has been made by said load with said sensing means or a part thereof thereby allowing the sensing of an electrical characteristic, the sensor means communicates with said control system so that the control system increments said drying time in proportion to the magnitude and frequency of said electrical characteristics which is representative of said moisture content, and load size respectively.

45. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 44, wherein said drying apparatus is a clothes dryer tumble clothes dryer.

46. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 45, wherein said load is clothes and/or articles or objects made of cloth and/or similar materials.

47. A sensing apparatus and control system in combination as claimed in any one of claims 36 to 46 wherein such sensing means or a part thereof includes two terminals of an impedance detection circuit.

48. A sensing apparatus and control system in combination as claimed in claim 47 wherein said terminals are each an elongate bar, which is a part of said sensing means positioned on a door and or in an outlet path of said drying apparatus.

49. A sensing apparatus and control system in combination as claimed in claim 48 wherein said elongate metal bars are electrically separated from each other.

50. A sensing apparatus and control system in combination as claimed in claim 48 or 49 wherein said metal bars are positioned parallel to each other.

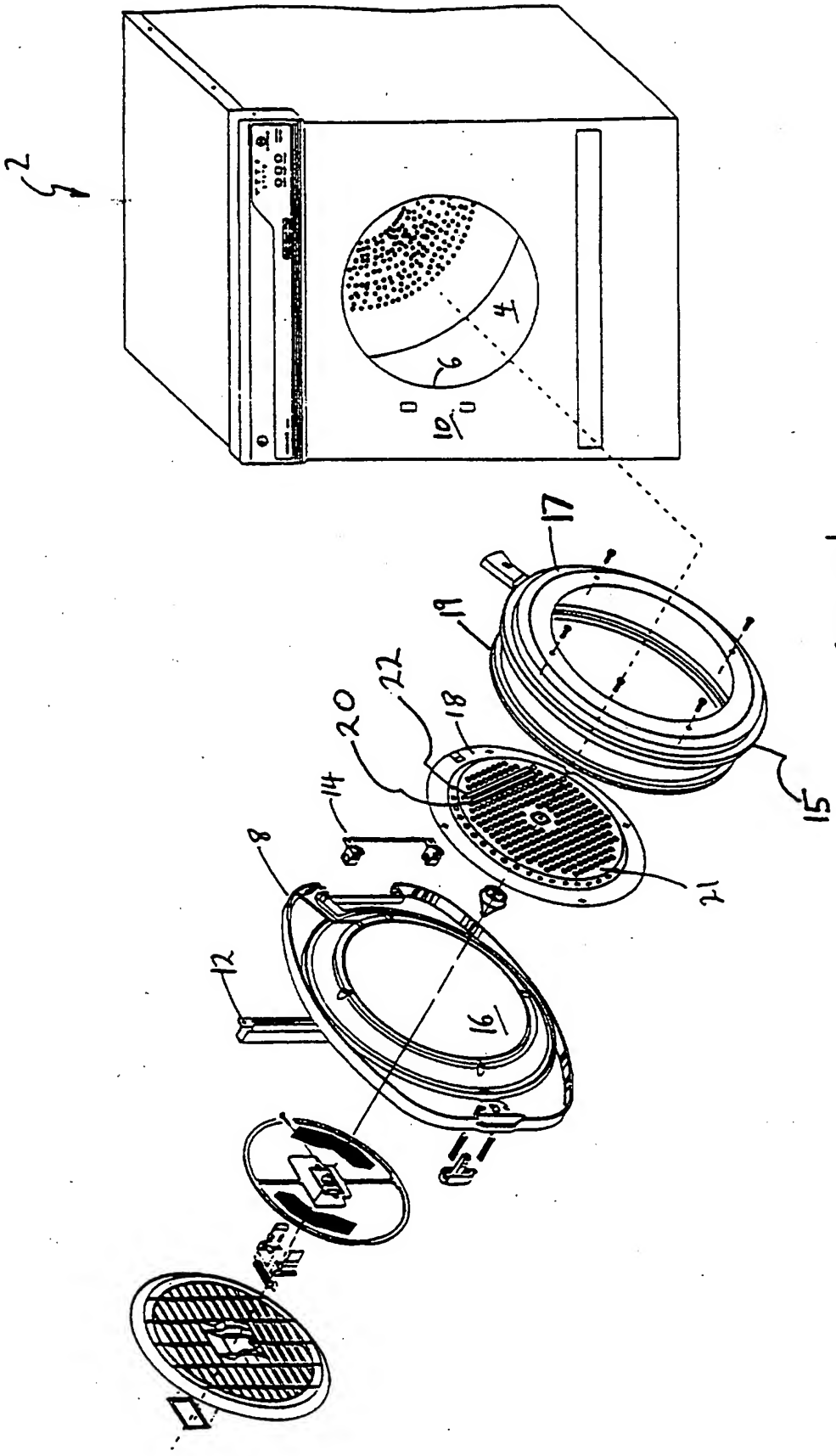

Figure1

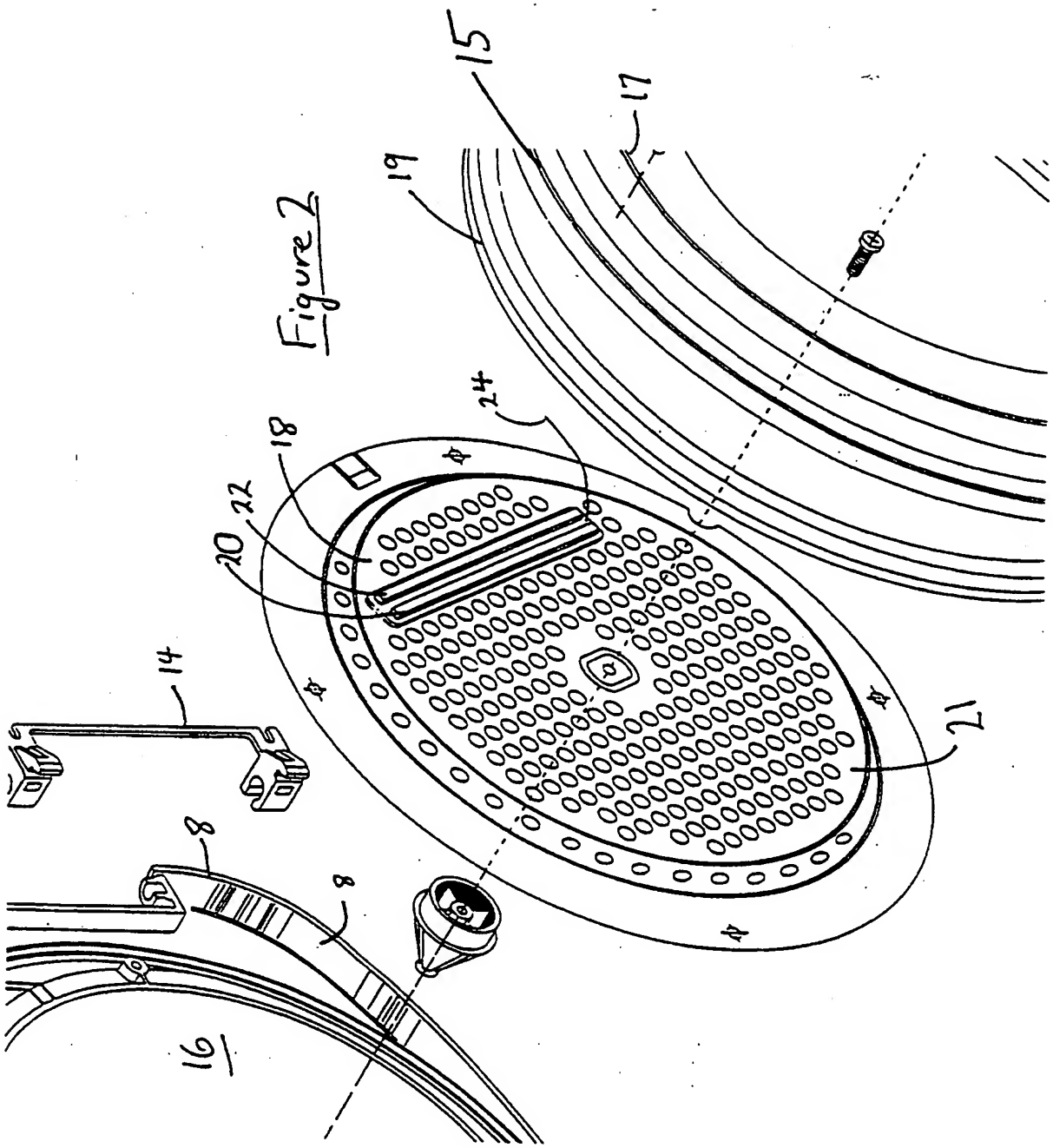

Figure 2

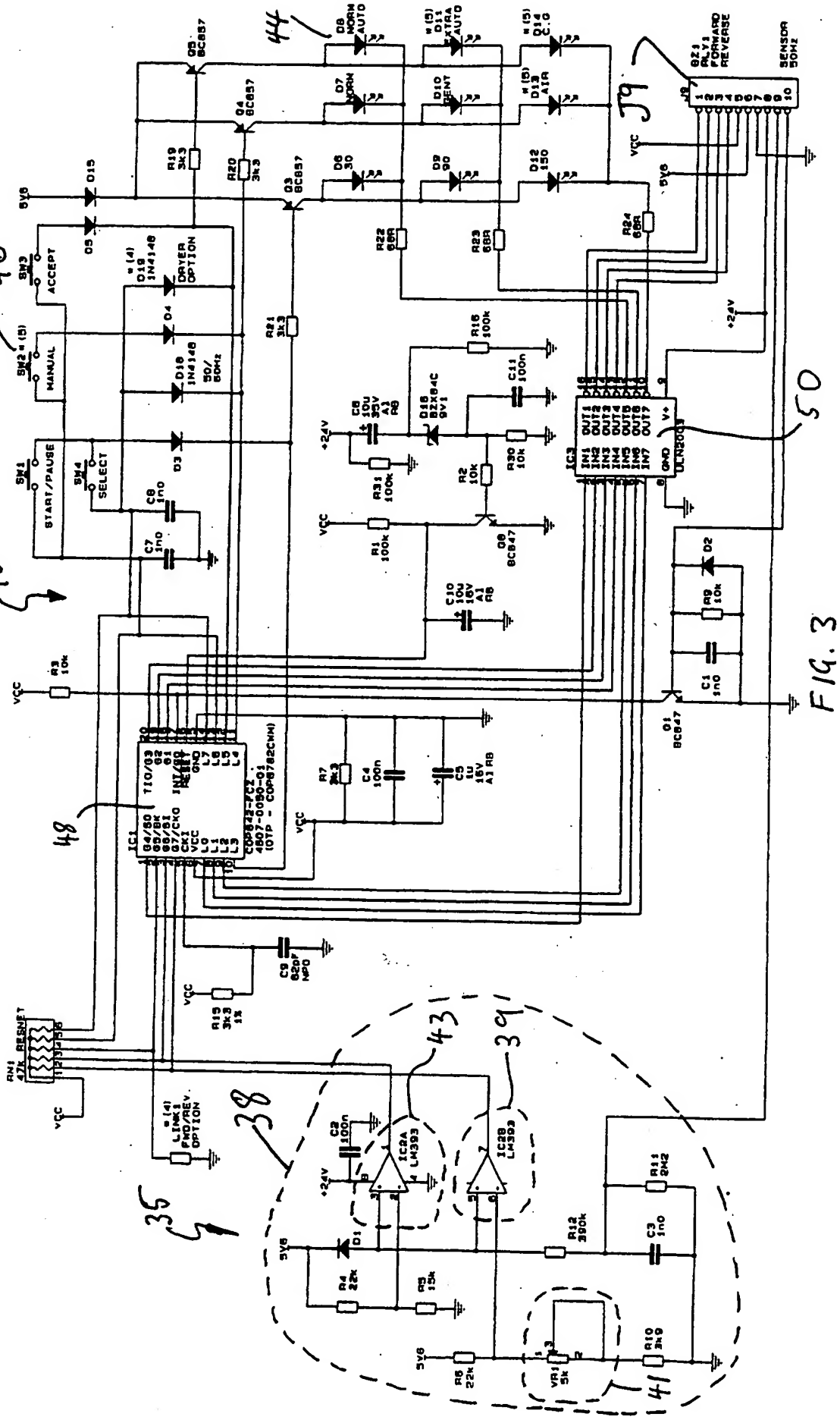
44
46
40
48
50
39
43
39
38
35
41
SW3 ACCEPT
SW2 MANUAL
SW1 START/PAUSE
SW4 SELECT
D8 MORN AUTO
D11 XTRA AUTO
D14 C.O
D7 MORN
D10 DENT
D13 A1A
D6 30
D9 90
D12 150
D15
D5
D4
D3
D18 50/60Hz
D19 1N4148 DRYER OPTION
D16 BZX84C 9V1
D17 LINK1 FWD/REV OPTION
D2
D1
Q5 BC857
Q4 BC857
Q3 BC857
Q6 BC847
Q1 BC847
IC1 COP842-FCZ 4807-0090-01 (OTP - COP8782CWM)
IC2A LM393
IC2B LM393
IC3 ULN2803
J9 BZ1 ALY1 FORWARD REVERSE
SENSOR 50HZ
RN1 47k RESNET
R1 100k
R2 10k
R3 10k
R4 22k
R5 15k
R6 22k
R7 2k2
R10 3k9
R11 2M2
R12 300k
R15 3k9 1%
R16 100k
R19 3k3
R20 3k3
R21 3k3
R22 68R
R23 68R
R24 68R
R30 10k
R31 100k
C1 1n0
C2 100n
C3 1n0
C4 100n
C5 1U 16V A1 RB
C6 10U 35V A1 RB
C7 1n0
C8 1n0
C9 82pF NP0
C10 10U 16V A1 RB
C11 100n
VR1 5k
5V6
+24V
VCC

FIG. 3

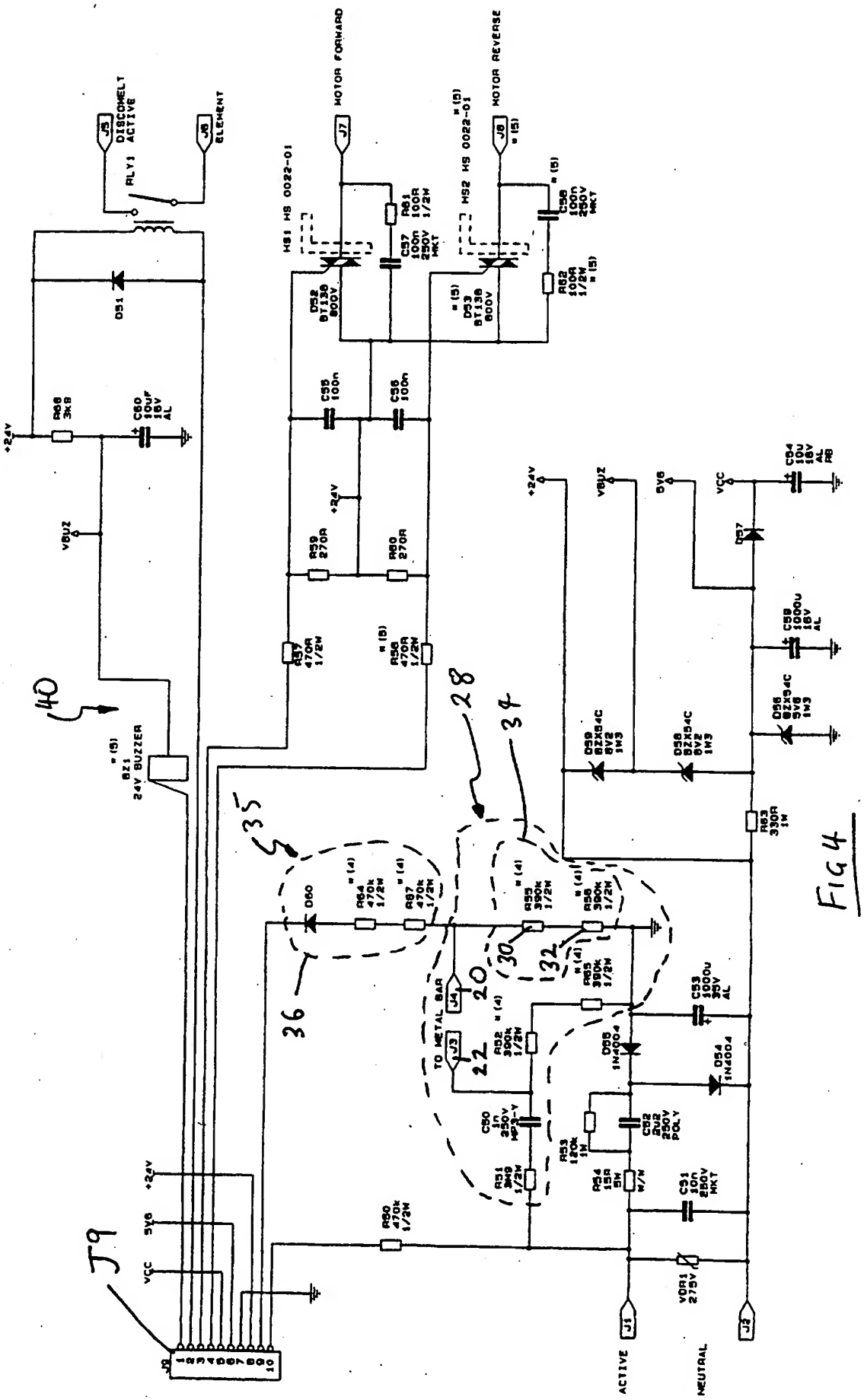
J5 DISCONNECT ACTIVE
J6 ELEMENT
RLY1
D51
R66 3K3
C60 10UF 16V AL
+24V
VBUZ
BZ1 24V BUZZER
HS1 HS 0022-01
HS2 HS 0022-01
J7 MOTOR FORWARD
J8 MOTOR REVERSE
R61 100R 1/2W
C57 100n 250V MKT
C58 100n 250V MKT
D52 BT136 800V
D53 BT136 800V
R62 100R 1/2W
C55 100n
C56 100n
R59 270R
R60 270R
R57 470R 1/2W
R58 470R 1/2W
D57
C54 10U 16V AL
C59 1000U 16V AL
D56 BZX84C 5V6 1W3
D58 BZX84C 8V2 1W3
D59 BZX84C 8V2 1W3
R63 330R 1W
D60
R54 470k 1/2W
R57 470k 1/2W
R55 390k 1/2W
R56 390k 1/2W
R65 390k 1/2W
R52 390k 1/2W
C53 1000U 35V AL
D55 1N4004
D54 1N4004
C50 1n 250V MP3-Y
R53 120k 1W
C52 22U 250V POLY
R51 240 1/2W
R54 15R 5W W/W
C51 10n 280V MKT
R50 470k 1/2W
VDR1 275V
J4 TO METAL BAR
J3
J1 ACTIVE
J2 NEUTRAL
J9
VCC
5V6
40
28
34
35
36
20
22
30
32

FIG 4

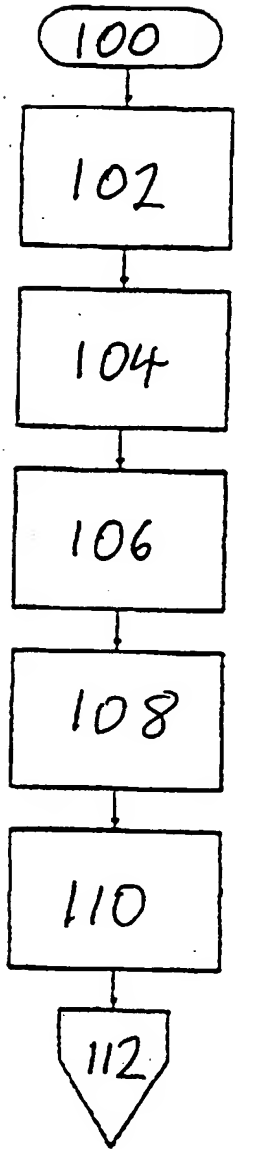

Figure 5

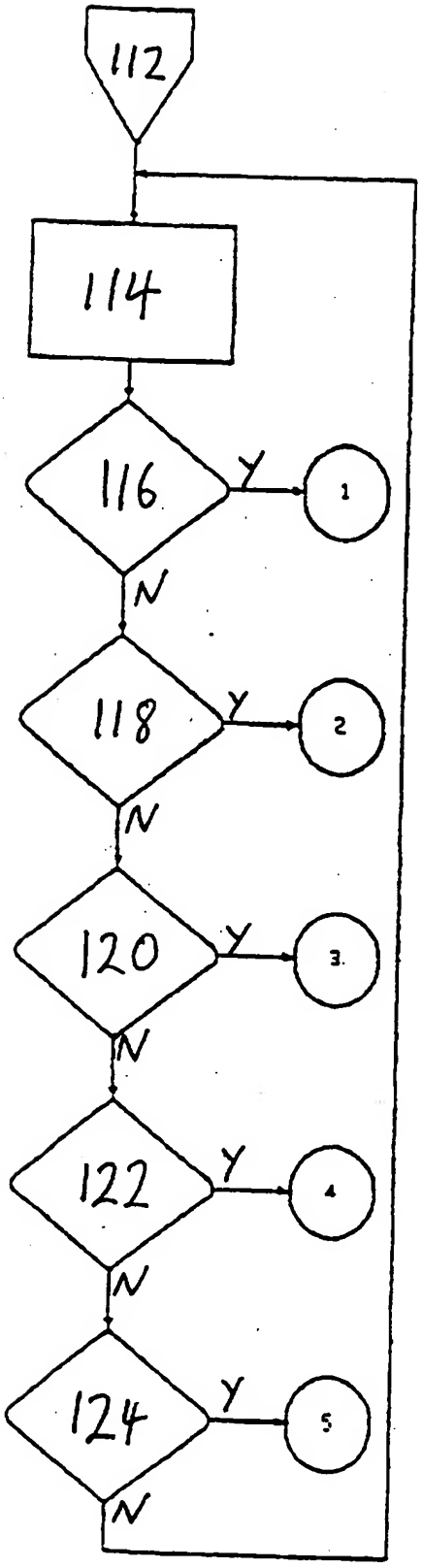

Figure 6

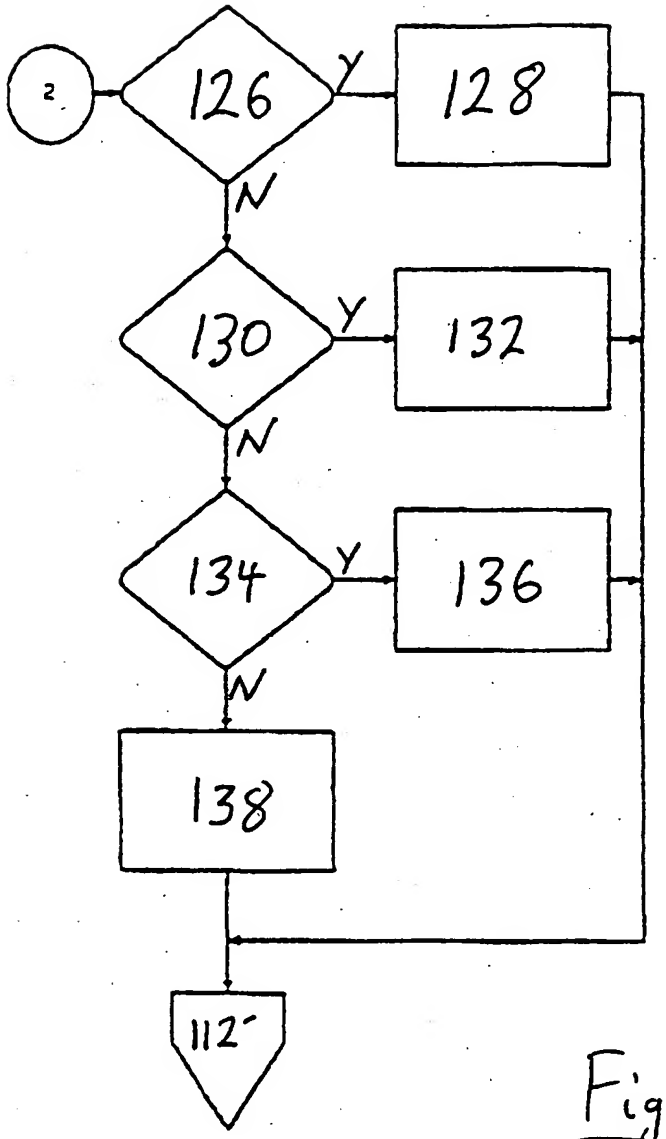

Figure 7

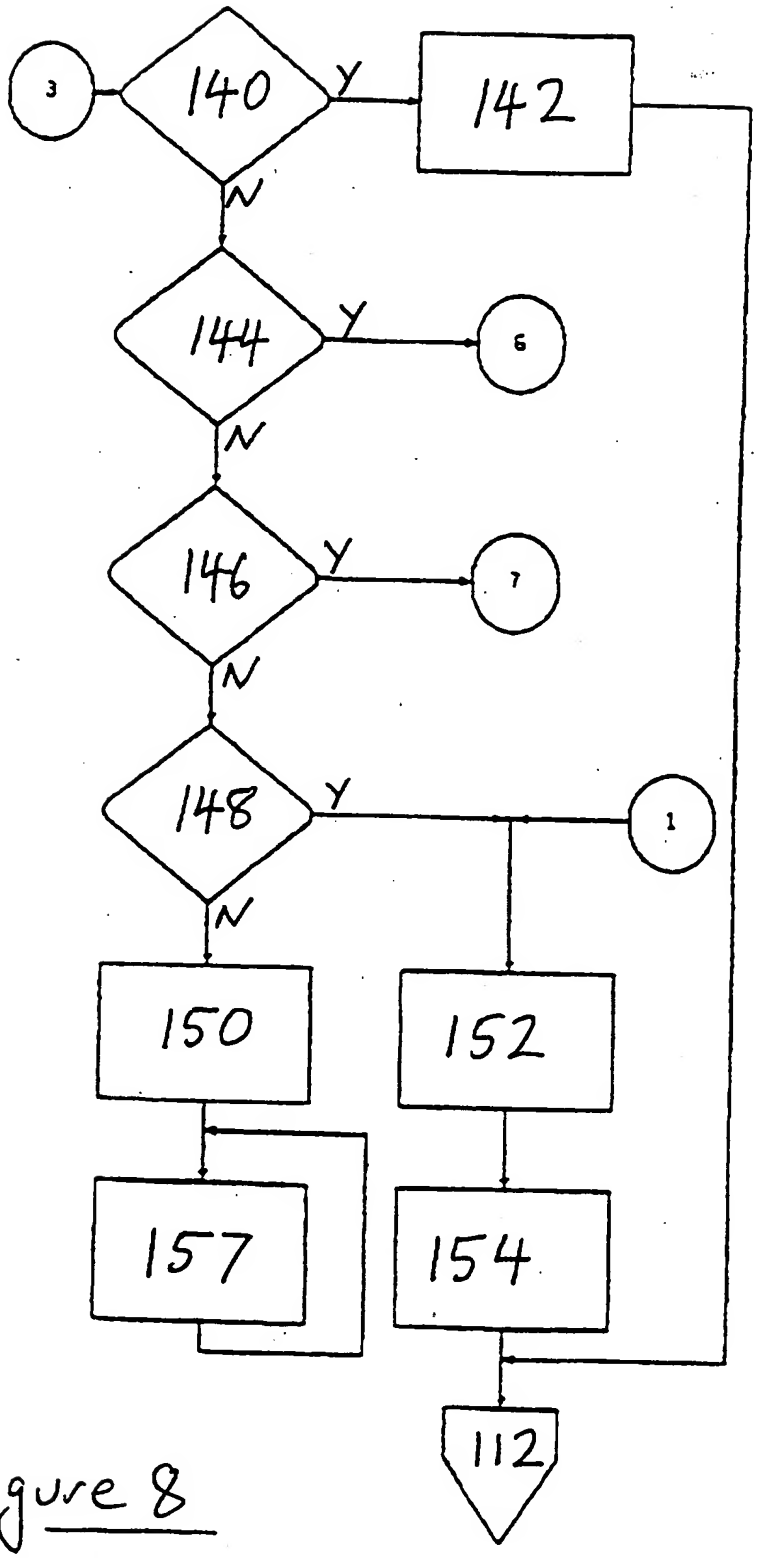

Figure 8

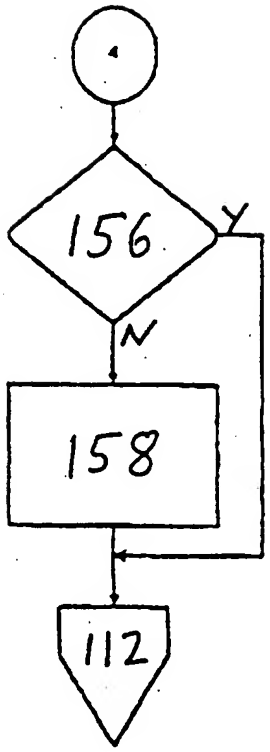

Figure 9

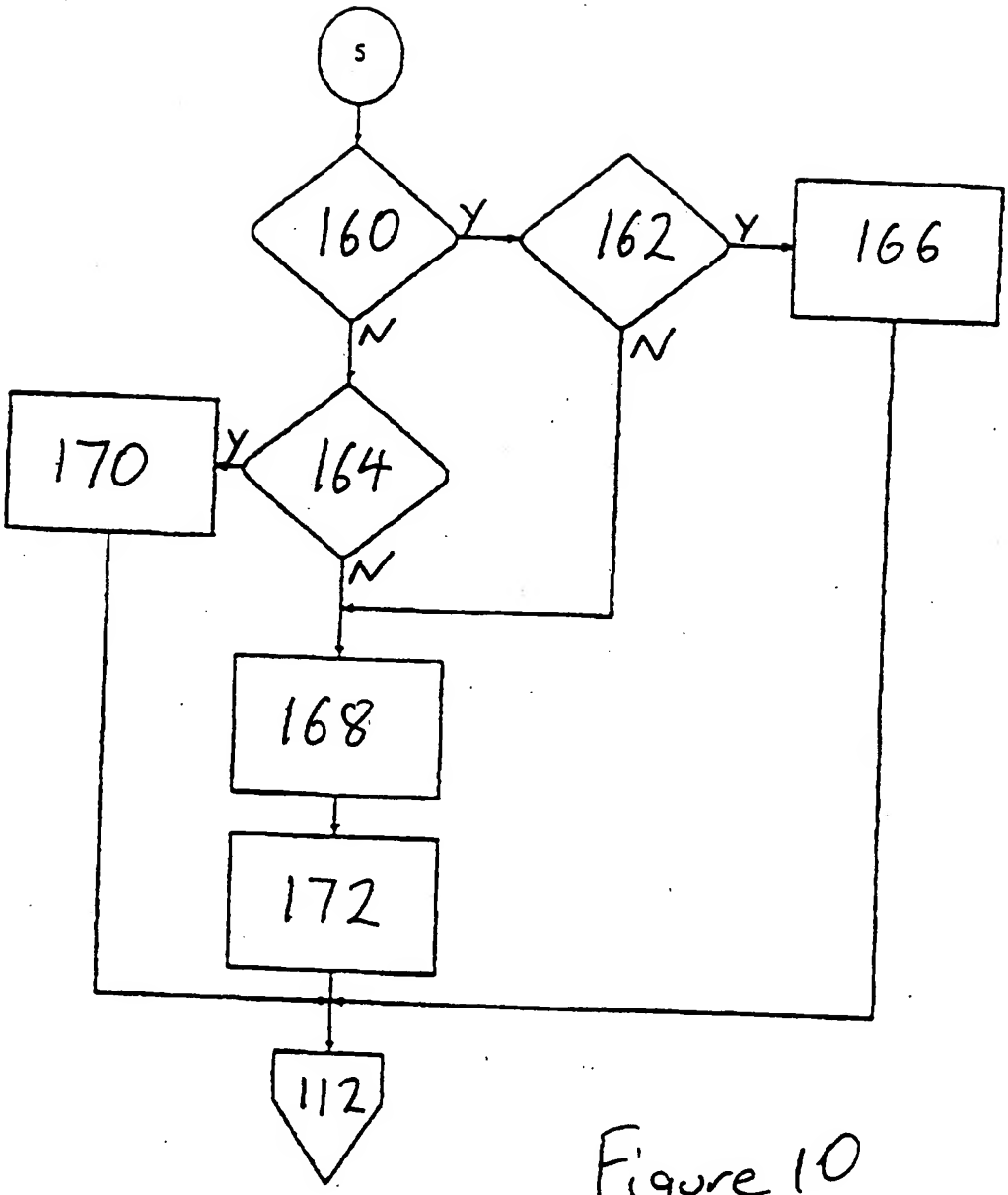

Figure 10

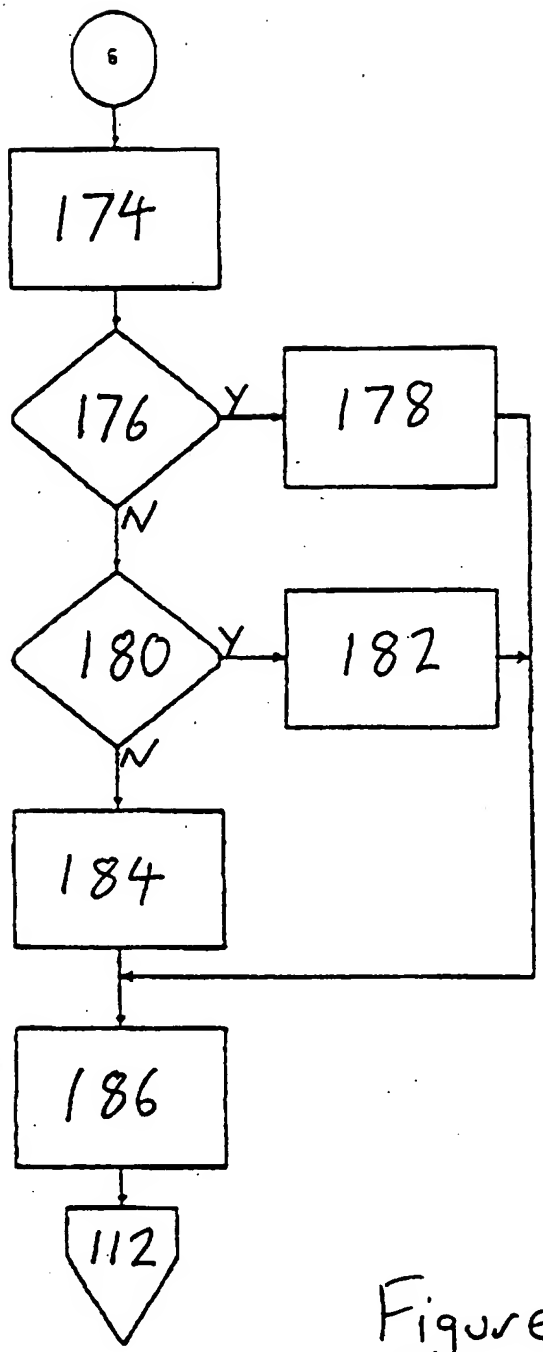

Figure 11

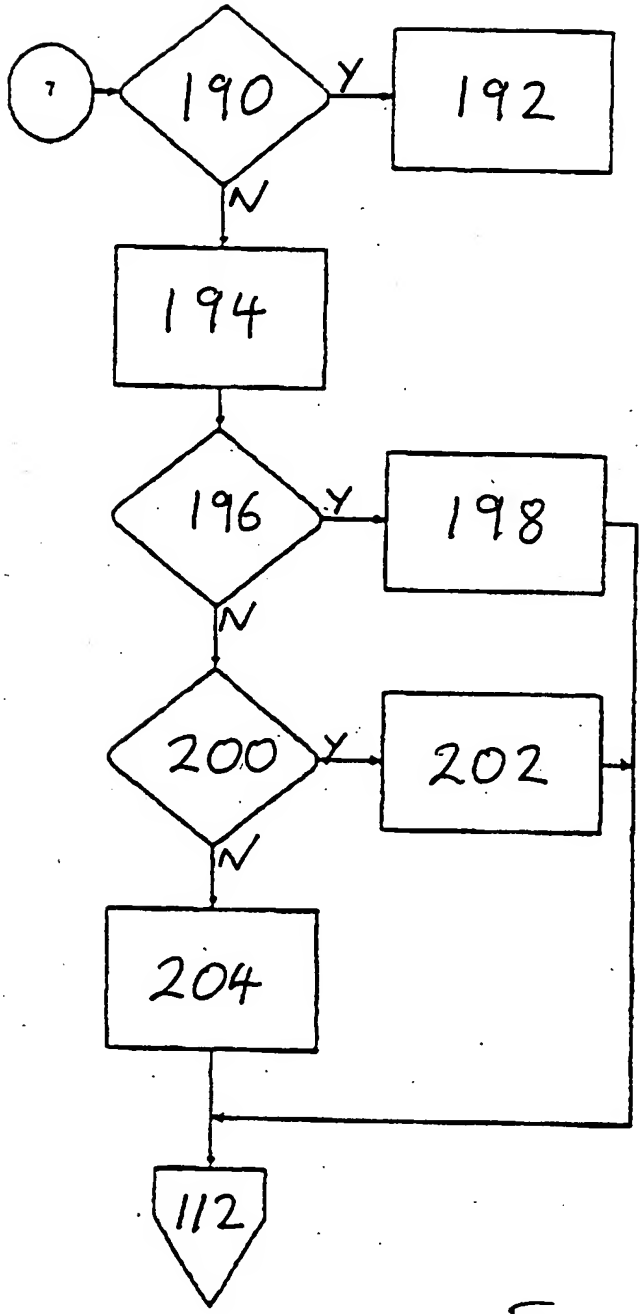

Figure 12

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00110

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: D06F 58/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : D06F 58/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2288867 A (TOSHIBA) 1 November 1995 see abstract	2, 4, 34
X	EP 226209 A (TOSHIBA) 24 June 1987 see abstract	1-50
X	Derwent Abstract Accession No. 95-370558/48 class F07 JP 07-250994 A (RINNAI CORP) 3 October 1995 see abstract	21, 34

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 May 1997	10 JUN 1997

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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00110

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, C1-45, page 83, JP 04-332599 A (MATSUSHITA) 8 May 1991	21, 34, 36
X	Derwent Abstract Accession No. 94-011161/02, class Z27, JP 05-317593 A (TOSHIBA) 3 December 1993 see abstract	1-50
X	DE 4013543 A1 (MIELE & CIE) 31 October 1991 see abstract	21, 36
X	Derwent Abstract Accession No. 93-004586/01 class Q76 JP 04-332599 A (MATSUSHITA) 19 November 1992 see abstract	1-50
X	Derwent Abstract Accession No. 89-141155/19 class F07 JP 01-085699 A (TOSHIBA) 29 September 1987 see abstract	1-50

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/AU 97/00110

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
DE	4013543						
GB	2288867						
EP	226209	FR	2586774	GB	2180019	JP	62052244
		US	4727768	JP	62055015	JP	62051916

END OF ANNEX